Center Independent Research & Development: GSFC IRAD

High Efficiency S-Band 20 Watt Amplifier

Completed Technology Project (2016 - 2017)

Project Introduction

This project includes the design and build of a prototype 20 W, high efficiency, S-Band amplifier. The design will incorporate the latest semiconductor technology, Gallium Nitride (GaN), which has superior thermal and efficiency performance over the traditional technology, Gallium Arsenide (GaAs). Power consumption and tuning will be optimized for the NASA Space Network (SN) return link service. This effort will significantly improve data rates on scientific balloons using the SN, and enable the Wallops Flight Facility range to improve over the horizon service for range customers.

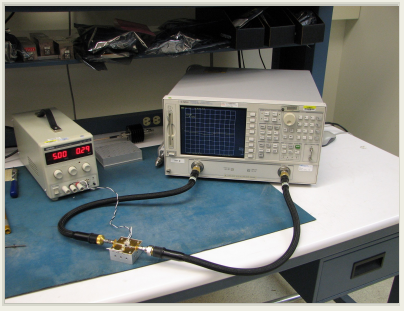
The objective of this project is to develop a highly efficient, prototype S-band (2200 to 2290 MHz) amplifier capable of at least 20 watts of RF output power. The final delivery for the project will be a flight ready prototype unit. The primay target appliciation is NASA scientific balloon missions. 20 W of output power is a four times increase over the present communications system, and results in a four times increase in data throughput as well. However, balloon craft use solar power and have limited power budgets. This requires a very efficient amplifier on the order of 40% in order to avoid flying additional solar panels.

This technology can also be incorporated into existing SN transmitters used for various Wallops range customers that may require over the horizon downlink capability. The new design will alleviate existing parts obsolescence issues and improve power efficiency and thermal requirements.

The goal is to design a single board amplifier module with a DC power conversion and associated enclosure. The amplifier will be a 2 or 3 stage module centered around a high power GaN transistor used for the output stage. The project includes part selection, part characterization, impedance matching for input, output, and inter-stage, and enclosure configuration. Output stage transistor selection will be driven by balancing output power and compression points. Transistor efficiency improves significantly when output stage operation moves into the non-linear region.

GaN parts will be selected for the high power transistor and driver stage. In the last 10 years, GaN has emerged as the technology of choice for all new RF/microwave designs, including satellite and communications electronics. GaN high power density opens up a whole new arena to higher power applications. For instance, GaAs has a power density of 1.5 W/mm while GaN is 5 to 12 W/mm. GaN parts are also capable of delivering higher efficiencies.

Board layout will follow manufacture recommendations for best thermal performance. This includes chip to board interface as well as board to enclosure mounting. To optimize overall module efficiency, a power conversion circuit will be designed to efficiently convert a typical unregulated flight system voltage to the regulated 28 volts and higher required for GaN transistor drain voltage.



Component Characterization

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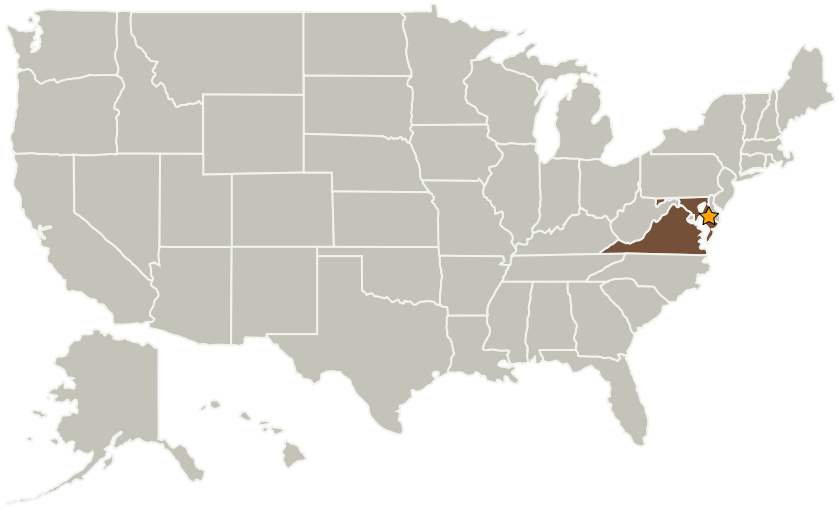
Anticipated Benefits

The primary benefit is improving the telemetry data rates on scientific balloons by a factor of four through the NASA Space Network.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Wallops Flight Facility(WFF)	Lead Organization	NASA Facility	Wallops Island, Virginia

Primary U.S. Work Locations	
Maryland	Virginia

Project Transitions

October 2016: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Wallops Flight Facility (WFF)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Managers:

Daniel A Mullinix
Wesley A Powell
Michael G Hitch

Principal Investigator:

Steven N Bundick

Co-Investigator:

Wei-chung Huang

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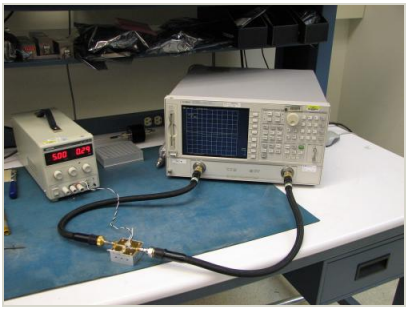
September 2017: Closed out

Closeout Summary: The purpose of the Goddard Space Flight Center's Internal Research and Development (IRAD) program is to support new technology development and to address scientific challenges. Each year, Principal Investigators (PIs) submit IRAD proposals and compete for funding for their development projects. Goddard's IRAD program supports eight Lines of Business: Astrophysics; Communications and Navigation; Cross-Cutting Technology and Capabilities; Earth Science; Heliophysics; Planetary Science; Science Small Satellites Technology; and Suborbital Platforms and Range Services.Task progress is evaluated twice a year at the Mid-term IRAD review and the end of the year. When the funding period has ended, the PIs compete again for IRAD funding or seek new sources of development and research funding or agree to external partnerships and collaborations. In some cases, when the development work has reached the appropriate Technology Readiness Level (TRL) level, the product is integrated into an actual NASA mission or used to support other government agencies. The technology may also be licensed out to the industry.The completion of a project does not necessarily indicate that the development work has stopped. The work could potentially continue in the future as a follow-on IRAD; or used in collaboration or partnership with Academia, Industry and other Government Agencies.If you are interested in partnering with NASA, see the TechPort Partnerships documentation available on the TechPort Help tab. http://techport.nasa.gov/help

Images



Component Characterization
Component Characterization
(https://techport.nasa.gov/image/26015)

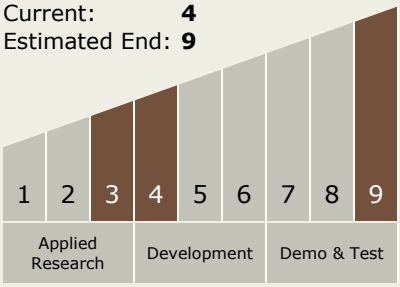
NASA
, NASA
(https://techport.nasa.gov/image/26016)

Project Website:

http://aetd.gsfc.nasa.gov

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **9**



Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.2 Radio Frequency
    - TX05.2.2 Power-Efficiency

Target Destination

Earth